Combat Urologic Trauma in US Military Overseas Contingency Operations

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Background: This article reports on the occurrences and patterns of genitourinary (GU) trauma in the contemporary high-intensity conflict of the overseas contingency operations (OCOs).

Methods: The Joint Theater Trauma Registry was queried for all US military members who received treatment for GU wounds and concomitant injuries sustained in OCOs for >75 months between October 2001 and January 2008.

Results: Of the 16,323 trauma admissions annotated in the Joint Theater Trauma Registry, 819 (5%) had one or more GU injuries. Of the GU casualties, 90% were sustained in Iraq and 65% were because of explosions. The average casualty age was 26 years (range, 18–58 years) and 98.5% were men. There were 887 unique GU injuries distributed as follows: scrotum, 257 (29.0%); kidney, 203 (22.9%); bladder, 189 (21.3%); penis, 126 (14.2%); testicle, 81 (9.1%); ureter, 24 (2.7%); and urethra, 7 (0.8%). Of the 203 patients with kidney injuries, 22% went to the operating room with 31 patients having nephrectomies. There were 189 bladder injuries with 26 patients (14%) having concomitant pelvic fractures.

Conclusions: This is the largest report of GU injuries during any military conflict. The distribution and percentage of casualties with GU injuries in the OCO are similar to those of previous conflicts. Consideration should be given to personnel protective equipment for the areas associated with GU injuries and predeployment training directed at the care of these injuries.

Key Words: Genitourinary injuries, OCO, JTTR.

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Historically, injury to genitourinary (GU) organs during war is between 0.5% and 8.0%.[1,2] The US military is currently engaged in various overseas contingency operations (OCOs). These conflicts involve hundreds of thousands of US service members and are the largest armed conflicts since the Vietnam War.[3] The few published reports documenting GU trauma during OCOs have only been from individual surgeons or medical centers.[2,4–7] Our goal was to report the occurrences and patterns of GU trauma in the contemporary conflicts of OCOs.

METHODS

The Joint Theater Trauma Registry (JTTR) is a database of medical information on patients treated in theater of combat operations at US military medical facilities.[8] Information is obtained from multiple levels of care, initiating at point of entry and terminating at military medical facilities in the United States. The database is continually updated by dedicated trauma research nurses who use data extracted from patients' paper medical charts. The data are limited to US military casualties.

The Institutional Review Board at Brook Army Medical Center approved a review of the JTTR. The JTTR was queried on all US service members receiving treatment for GU wounds (International Classification of Diseases–9th Revision [ICD-9] codes 55–72 and 605–942) sustained for >75 months between October 2001 and January 2008. Distinct patients within each ICD-9 code were counted to eliminate multiple inclusions of injuries at different levels of care. This query did not include combatants classified as having returned to duty to be consistent with casualty reporting from previous wars. In addition, combatants sustaining nonbattle injuries were also excluded. We analyzed the results by each ICD-9 code and then compared and contrasted the data with published results from previous large-scale conflicts.[9–11]

Descriptive statistics were used to describe the GU patient population. Data are presented as percentages of the total number of records or within the population to the number of GU injuries. Means with ranges are presented for continuous data.

RESULTS

There are >45,000 US trauma casualties to date with 16,323 trauma admission entries in the JTTR. There were 819 patients, 5% of the population, with one or more GU injuries for a total of 887 GU injuries. Of the GU casualties, 90% were sustained in Iraq. The average casualty age was 26 years (range, 18–58 years). Four patients (0.5%) died with significant abdominal injuries and GU injuries. US Army personnel accounted for a majority of the wounded combatants, followed by US Marine, Navy, and Air Force personnel. The median military rank was enlisted grade E-4. Female combatants comprised 1.5% of the casualties.

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Of the 887 GU injuries, 257 (29.0%) injuries were in the scrotum, 203 (22.9%) in the kidney, 189 (21.3%) in the bladder, 126 (14.2%) in the penis, 81 (9.1%) in the testicle, 24 (2.7%) in the ureter, and 7 (0.8%) in the urethra (Fig. 1). These GU injuries included 535 (65.3%) caused by explosions, 121 (14.8%) by penetrating trauma, 87 (10.6%) by blunt trauma, and 10 (1.2%) by burns. The type for 66 (8.1%) injuries was not documented.

Of the 257 scrotal injuries, 213 were caused by explosion, 40 were because of penetrating trauma, and 4 injuries did not have the mechanism of injury documented. The predominant injury type was penetrating. Eighty-four patients (33%) were taken to the operating room (OR) for scrotal and/or testicular exploration/repair. In addition, there were a total of 81 (32%) testicle injuries with all patients undergoing operative intervention. Thus, scrotal-testicular injuries accounted for 38% of GU injuries.

Of the 203 kidney injuries, 44 patients (22%) went to the OR and 31 (15%) patients underwent nephrectomies. Seven patients had a partial nephrectomy/repair of renal laceration, and six were drained or observed.

Of the 189 bladder injuries, operative intervention was required in 89 patients (47%) and 26 patients (7%) had a concomitant pelvic fracture. Fourteen suprapubic tubes were placed.

There were a total of 126 penile injuries, 32 patients (25%) with penile injuries went to the OR, and 22 (17%) were treated with suture repair of a penis laceration. Of the 24 ureteral injuries, 13 were caused by penetrating trauma and 11 were caused by explosions. There were 7 urethral injuries, 3 because of a blunt mechanism, 2 undocumented, 1 with a penetrating injury, and 1 because of explosion.

DISCUSSION

OCOs are the largest US conflicts since the Vietnam War. Since the combat began in October 2001, there have been reports of GU injuries from individual institutions and surgeons despite global delivery of care.[2,4–7] This study is the first to look at the totality of GU injuries and demonstrates that 5% of all US service member trauma admissions sustained GU injuries.

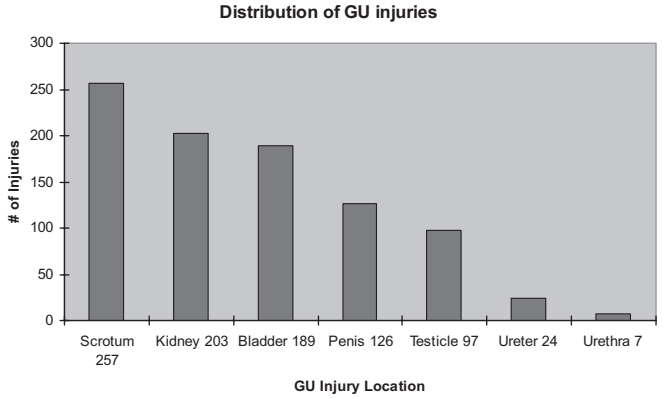

Figure 1. Distribution of GU injuries in OCOs.

There have been an estimated 45,000 casualties in OCOs. The majority of those who were injured returned to duty. The JTTR abstracts the medical data on every American military trauma admission cared for in US military facilities. These admissions represent 36.3% of the estimated casualties during the timeframe analyzed. We recognize that registries have numerous limitations; however, these databases allow access to information on a large numbers of patients to describe a population of interest. This report is the largest report to date for any GU injuries during any military conflict.

Explosive devices and high-velocity weapons, primarily automatic rifles, are the predominant means of injury in OCOs. The injuries caused by explosions create a combination of blast and debris that then penetrates the casualty and can be coupled with a blunt trauma effect.[12,13] In this study, 65% of the injuries were due to explosions, 15% to penetrating trauma (firearms), 11% to blunt injury, and the remaining to other mechanisms. Paquette[2] reported that during his year in Iraq, explosions were responsible for 50% of injuries, followed by firearms for 37%, and blunt trauma for 13%. Thus, penetrating injury is the primary mechanism of injury during OCOs.[3] In Vietnam, 80% of GU injuries were because of penetrating trauma, predominantly as a result of explosions,[11] similar to that in this study.

Historically, the rate of GU injuries during war varies between 0.51% and 4.2% of the patients admitted (Table 1).[2,9–11,13–18] GU injuries occurred in 0.51% of casualties during the Iraq war, whereas GU injuries during the Bosnia and Croatia conflicts varied between 2.4% and 3.6%.[10,13,14] Data from World War II demonstrate a GU injury rate between 0.7% and 2.6%.[9] In Vietnam, the reported rate ranged from 3% to 4.2%, similar to the 5% rate noted for OCOs.[11,16]

The incidence rate for GU injuries, 5%, involving 819 patients must be put in context. In OCOs, there is a preponderance of injuries to the extremities (54%), 5% of patients have vascular injuries and 5% undergo amputations.[3,19–21] Ocular injuries occur in 6% to 17% of patients, and 3% to 5% have burns.[22–24] Moderate or severe traumatic brain injury occurs in ~5% of patients.[25] Thus, GU injuries, although not as life threatening as some of those mentioned previously with a prevalence rate of 5%, represent a significant burden of injury.

TABLE 1. Comparison of GU Injuries in the Current Conflict to Previous Conflicts as a Percentage of Total Injuries

Location of Injury	Current Conflict	Baghdad CSH[2]	Bosnia and Croatia[10]	Vietnam[11]	World War II[9]
Kidney	22.9	29.6	39.6	19.1	40
Ureter	2.7	2.0	7.8	5.2	3.3
Bladder	21.3	13.3	17.2	10.4	11.6
Urethra	0.8	17.3	4.6	12.0	15
Scrotum	29.0	19.4	22.7	32.8	30
Testicle	9.1	12.2	*	*	†
Penis	14.2	6.1	8.1	18.5	†

* Testicular trauma is categorized as scrotal trauma in these studies.
† Testicular and penis trauma is categorized as scrotal trauma in this study.

Because of the documentation and the proximity of the testicle in the scrotum, there are often overlaps of patients diagnosed with scrotal and testicle injuries. In OCOs, scrotal-testicular injuries were the most common GU injury, 38%. In Vietnam, the rate of scrotal-testicular involvement ranged from 25% to 35%.[11] In both conflicts, the predominant causes of injury were penetrating agents. The higher rate of scrotal and testicle injuries than in previous conflicts is likely because of explosions. It is possible that casualties occur while soldiers are sitting in vehicles, and if an explosion occurs from below, there is an increased probability that the perineum will be harmed. Interestingly, there is a high concordance rate that if a patient has a testicle injury, a surgical repair is performed, whereas some scrotal injuries are nonoperative.

The kidney was involved in 1.2% of all casualties. Hardaway[26] reported the same rate for casualties in Vietnam. The rate of kidney injuries was 22% of GU injuries in this study. This rate is very similar to that reported for Vietnam (19–35%) and earlier in OCOs as reported by Paquette[2] (30%).[11] Of interest, in this conflict, the rates of nephrectomies and partial nephrectomies were 15% and 3% of kidney injuries, respectively, in contrast to 39% and 14% during the Vietnam War.[11] This reduction in operative intervention may be because of the availability of improved imaging afforded by contrast-enhanced computed tomography to better define nonoperative management of the injury with renal trauma.

Renal salvage is always a paramount concern, but war conditions and concomitant injuries and hemodynamic status determine patient care. Voelzke and McAninch[27,28] recently reviewed the outcome of civilian patients with penetration renal injuries caused by gunshot wounds. They reported a renal salvage rate of 85%, identical to that found in this study. Of note, Narkun-Burgess et al.[29] reviewed military members who had a nephrectomy during World War II and determined that there were no additional adverse events as a result of the nephrectomy with a follow-up of up to 45 years.

The incidence of bladder injury is 21% in OCOs. This rate is higher than that reported in Vietnam, i.e, 10% to 14%.[11] Of the 89 patients with bladder injuries managed operatively in this study, 29% had pelvic fractures. The rate was similar in Vietnam, where 32% had bony pelvic wounds.[11] Of the operative patients from OCOs, 16% had suprapubic tubes placed similar to the 28% in Vietnam. It is well described that 7% to 25% of patients with lower urinary tract trauma (including bladder and urethral injury) have pelvic fractures; and in patients with blunt trauma, the incidence is higher.[30] The low pelvic fracture rate in military patients may be because of the high percentage of penetrating injuries due to explosions rather than the blunt injuries seen in the civilian setting.

Injuries of the external genitalia are common as noted by the high incidence rate for injuries to the scrotal-testicular area. Injury to the penis occurred at a lower rate of 14%. The incidence rate was similar to that reported during the Vietnam War, i.e, 18%.[11] Of note, in this study, a quarter of these patients were taken to the OR.

In the current series, there are a total of 24 (2.7%) ureteral injuries. In Vietnam, the rate was higher at 5%. Historically, ureteral injuries due to external trauma are infrequent, involving $<1\%$ of all GU tract trauma and are usually associated with injury to other major abdominal organs.[31] Slightly $>50\%$ of the ureteral injuries in OCOs are caused by penetrating trauma, which is consistent with civilian data. There are a total of seven solitary urethral injuries in OCOs, likely because of an overlap between penile and urethral injury documentation. When considering the seven urethral injuries, the majority of injuries are found to be caused by blunt mechanism.

The JTTR does not document which casualties were wearing personnel protective equipment (PPE) at the time of injury. Therefore, we are unable to make conclusions about the efficacy of body armor in OCOs. We do know that US soldiers were provided with body armor and that as the conflict intensified, a scrotal protective device attached to the body armor was added for protection.[2] The difference in kidney injuries from World War II to the Vietnam War has been attributed to the use of PPE.[1,11] Paquette[2] recently reported that during OCOs, a significant reduction in GU injuries, especially kidney injuries, occurred in patients wearing PPE.

CONCLUSIONS

A significant number of US casualties (5%) in OCOs had one or more GU injuries. Explosions caused the majority of the injuries, except for injuries to the urethra and the ureter. The scrotum was the most commonly injured GU organ. For a casualty with a renal injury who goes to the OR, there was a 71% nephrectomy rate.[6] The data presented and reviews of injury patterns are important for research and development, training, and resource allocations. As recently noted by Waxman et al.,[6] the incidence of GU injuries warrants deploying general surgeons who receive a review of the management of GU injuries as part of their predeployment training.

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DISCUSSION

Dr. Andrew C. Peterson (Madigan Army Medical Center, Tacoma, WA): The authors describe the largest series for combat-related trauma in the literature based on a prospective centralized database. The article is clearly written (clear objectives and clear conclusions) and represents a significant contribution to the literature.

It would be helpful if the authors commented that the database was a prospective database with data entered by dedicated coordinators throughout the patient care experience. The authors should also comment on what population is included in the database clearly. We know that American service members are included; however, are there data on coalition forces, civilians, and others, including Department of Defense employees, etc.?

In the Results section (first paragraph), the authors comment that four patients with GU injuries died. Did these four patients have isolated GU injuries, or were there other more devastating injuries (head or intra-abdominal) that contributed to the death? Please comment on this.

The second paragraph states that there were 887 GU injuries. How many of these, when broken down, had a combination of scrotum, kidney, bladder, etc.? In other words, were all these injuries isolated single injuries? It is important to determine for the reader how many of these patients had multiple GU injuries.

The authors also comment that of the kidney injuries, several needed nephrectomy. Can the authors comment on whether these renal explorations were performed by general surgeons, urologists, or a combination thereof? As well documented in the literature, when laparotomy is performed with renal exploration by general surgeons, this tends to result in a higher rate of nephrectomy. Did the authors see this in the database?

In the Discussion section (third paragraph), the authors comment that explosive devices and high-velocity weapons are the predominant means of injury. They also comment on Dr. Paquette's article. They need to comment on the time frame and how the conflict has changed over the years with different types of weaponry used throughout the conflict and correlate that with the types of injuries that are logged in the database. In other words, did the introduction of the explosive device change the injuries after the initial invasion of the war was over?

Dr. Faye Serkin (Brooke Army Medical Center, Fort Sam Houston, TX): Thank you for your comments, Dr. Peterson. My point-by-point responses follow:

The database is continually updated by dedicated trauma research nurses who use data extracted from patients' paper medical charts. The data are limited to US military casualties.

The patients in our study had significant abdominal injuries: four patients (0.5%) died, all with significant abdominal injuries and GU injuries. There were 819 patients, 5% of the population, with one or more GU injuries for a total of 887 GU injuries.

There is no information in the database on the background or training of the surgeons.

Unfortunately, data on the change in the tempo and weapons causing the injuries are not available in the medical records. Over the course of the conflict, explosions have been the primary cause of injury.

Again, the reviewers' time and effort has been helpful to us, and we have attempted to incorporate their comments in the article.

